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Energy Management in Small Commercial Buildings: A Look at How HVAC Contractors Can Deliver Energy Efficiency to this Segment

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July 2014

Citation:
Hult, E., Granderson, J., Mathew, P., Energy Management in Small Commercial Buildings, *RSES Journal*, July 2014.

Acknowledgments
This work was supported by the Assistant Secretary for Energy Efficiency and Renewable Energy, Building Technologies Program, of the U.S. Department of Energy under Contract No. DE-AC02-05CH11231. The authors also thank the technical review committee and editor at RSES Journal for their valuable contributions, as well as all of the partner contractors who have participated in the package demonstration.

Abstract

While buildings smaller than 50,000 sq ft account for nearly half of the energy used in US commercial buildings, energy efficiency programs to-date have primarily focused on larger buildings. Interviews with stakeholders and a review of the literature indicate interest in energy efficiency from the small commercial building sector, provided solutions are simple and low-cost. An approach to deliver energy management to small commercial buildings via HVAC contractors and preliminary demonstration findings are presented. The energy management package (EMP) developed includes five technical elements: benchmarking and analysis of monthly energy use; analysis of interval electricity data (if available), a one-hour onsite walkthrough, communication with the building owner, and checking of results. This data-driven approach tracks performance and identifies low-cost opportunities, using guidelines and worksheets for each element to streamline the delivery process and minimize the formal training required. This energy management approach is unique from, but often complementary to conventional quality maintenance or retrofit-focused programs targeting the small commercial segment. Because HVAC contractors already serve these clients, the transaction cost to market and deliver energy management services can be reduced to the order of hundreds of dollars per year. This business model, outlined briefly in this report, enables the offering to benefit the contractor and client even at the modest expected energy savings in small buildings. Results from a small-scale pilot of this approach validated that the EMP could be delivered by contractors in 4-8 hours per building per year, and that energy savings of 3-5% are feasible through this approach.

Keywords: Energy management, energy information systems, HVAC, Green Button

Efforts to reduce commercial-building energy use are increasingly expanding to consider small buildings. Of the U.S. commercial building stock, 95% of buildings are 50,000 sq ft or less, and these small buildings use 44% of commercial-building energy (CBECS 2003). However, achieving savings in small commercial buildings can be challenging. In response, researchers at the Lawrence Berkeley National Laboratory have adapted the continuous energy management process, i.e., a set of business practices to continuously track and manage energy use, for application in small commercial buildings. The objective of this project, funded by the US Department of Energy was to identify a market-viable approach to use energy management to achieve energy savings in the small commercial segment. The approach includes analysis of monthly and interval (hourly or sub hourly) energy use data, cross-sectional benchmarking, a brief walkthrough, communication materials and verification of results.

Monitoring-based commissioning has been shown to save energy in larger facilities. In smaller buildings, however, there is often no dedicated facilities manager supervising building operations, and often facility operations, maintenance and bill-payment responsibilities are split across multiple people. Firms occupying these buildings tend to have lower awareness of energy-use patterns than those in larger buildings (Schleich and Gruber 2008). One study of small commercial spaces in a New Jersey mall noted that business owners and managers that were interviewed repeatedly stated, "I can't do anything about [energy costs]" (Komor et al. 1989). Smaller building size translates to lower total potential energy and cost savings than in larger buildings, and transaction costs can therefore limit offerings for this segment.

Fig 1: The Energy Management Package consists of five technical elements to provide simple, step-by-step guidance to contractors interested in offering energy-management options to their customers.

To better understand the opportunities and barriers to energy-management solutions in the small commercial segment, industry stakeholders were interviewed, including utility program managers, software vendors and HVAC contractors. Overall, contractors suggested that perhaps one-quarter of small

commercial building owners are motivated to reduce energy use, and a larger segment is aware of potential savings but is wary of making investments. Few energy-management tools and services are specifically targeted to this market segment but interviewees indicated interest, particularly in benchmarking and performance tracking. Consistent feedback was that any tools or services developed should be simple to use and provide actionable information. Lowering transaction costs to tens to hundreds of dollars per year per building is likely necessary for marketability of offerings for the small commercial sector.

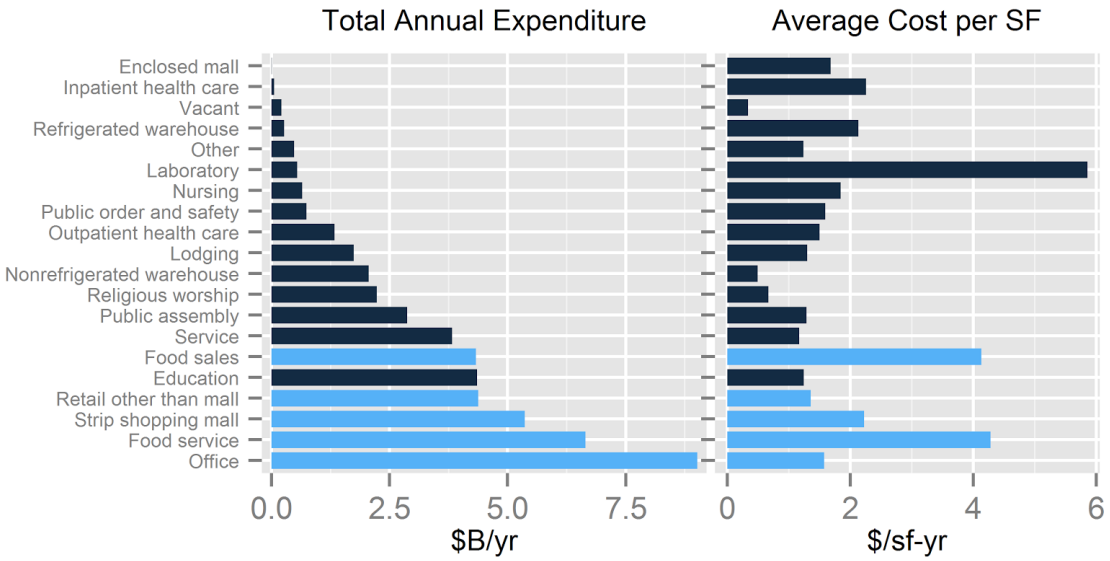

Fig 2: For buildings less than 50,000 sf, total annual energy expenditure (left); average annual cost per square foot (right), from CBECS (2003). Light bars are the segments targeted in this study.

The Energy Management Package (EMP) developed with stakeholder feedback, targets 3%–5% energy savings in small commercial buildings by tracking performance and identifying no- and low-cost energy-conservation measures. Targeted measures are primarily operational, such as maintaining appropriate setpoints and scheduling for thermostats and lighting, with the inclusion of some low-cost retrofit measures, such as installing occupancy sensors or replacing inefficient lighting sources.

A variety of delivery channels were considered, including deployment by utilities and direct purchase from software vendors. The option of deployment by HVAC or mechanical contractors was identified as the most promising, as contractors have existing relationships with small commercial customers and visit these buildings regularly for maintenance and service, thereby lowering the transaction cost to deliver energy management services.

1. Technical Elements of the Energy Management Package

The EMP comprises a set of practical resources for energy management, including guidelines, worksheets, a simple reporting tool as well as an associated business model. The EMP is designed to provide simple, step-by-step guidance to minimize required training and leverages existing, low-cost or free software tools for analysis portions. A list of software tools is included in the package for informational purposes, but is neither an endorsement, nor a comprehensive list.

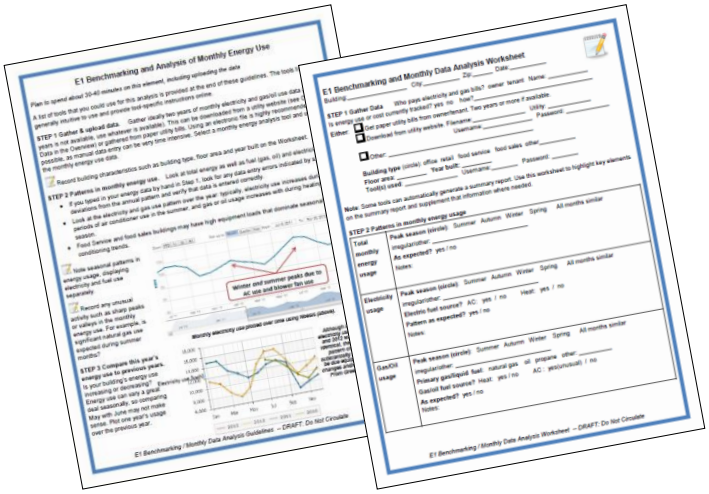

Fig 3: Each technical element of the package contains a set of guidelines (left) and a worksheet (right).

The package is divided into five technical elements outlined below:

Element 1—Benchmarking and analysis of monthly data: Either the Energy Star Score or the energy-use intensity (annual site energy use/sq ft) for the previous 12 months is used to convey to the owner how their building is performing relative to peers. Those with larger portfolios can also use this metric to identify which buildings might benefit most from energy management and upgrades. Monthly electricity and fuel use is plotted to illustrate seasonal patterns and trends from year to year. To focus efficiency efforts, this analysis can highlight step changes in energy consumption.

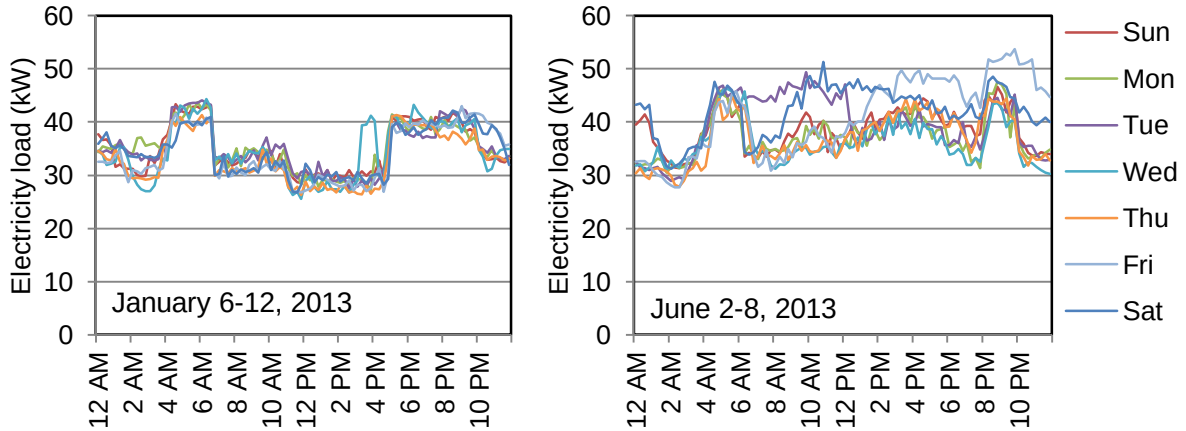

Fig 4: Daily load profile by day of the week for January (left) and June (right) at a 3000 sq ft fast food restaurant in California.

Element 2—Analysis of interval data: Up to 12 months of hourly or sub-hourly electricity data is plotted to determine how much energy is used at specific times of day. This reveals opportunities associated with scheduling, overnight setbacks, base load, peak load and irregular behavior. Time-varying energy use is

shown for a sample building in Figure 4.

Element 3—Walkthrough: This element outlines a one hour onsite walkthrough to identify low- and no-cost energy-efficiency measures, such as adjustments to thermostat and lighting controls. The worksheet contains a checklist of 15 items that can be answered by walking through the occupied spaces and speaking with the site manager or owner.

Element 4—Communicating with the owner: This element guides the contractor through summarizing building performance, identifying efficiency measures and pitching measures to the building owner. Interviewees commented that fast and straightforward reporting is critical to selling efficiency measures, so a simple spreadsheet is included that automatically generates a summary of performance findings and a table of the measures recommended by the contractor. Non-energy benefits, such as improved lighting conditions and thermal comfort, are also discussed.

Element 5—Checking results: This element covers how to use tools from Elements 1 and 2 to verify savings, and how to verify that scheduling, setback changes, and other improvements have been implemented. Further steps are included for those interested in more substantial upgrades. Users are encouraged to institute a schedule for continued energy management to ensure savings persist.

2. EMP Business Model

Based on contractor interviews, the major benefit to offering this service is to build customer relationships and establish trust. Rather than spend money on advertising to improve customer recruitment and retention, a contractor could deliver added value through utility cost savings. To this end, contractors have appreciated how this package can quantify savings for other improvements they may have made at a site, such as installing more efficient equipment or repairing an economizer. This offering would likely be most attractive to contractors and building owners who are value-oriented rather than price-oriented. Additional benefits include differentiation and identification of service opportunities.

For the customer, beyond utility cost savings, energy upgrades often lead to improved indoor environmental conditions, including lighting quality, thermal comfort and productivity. One contractor commented, “We’ve found thermal comfort and energy efficiency often go hand-in-hand.” Additional customer benefits can include reduced maintenance.

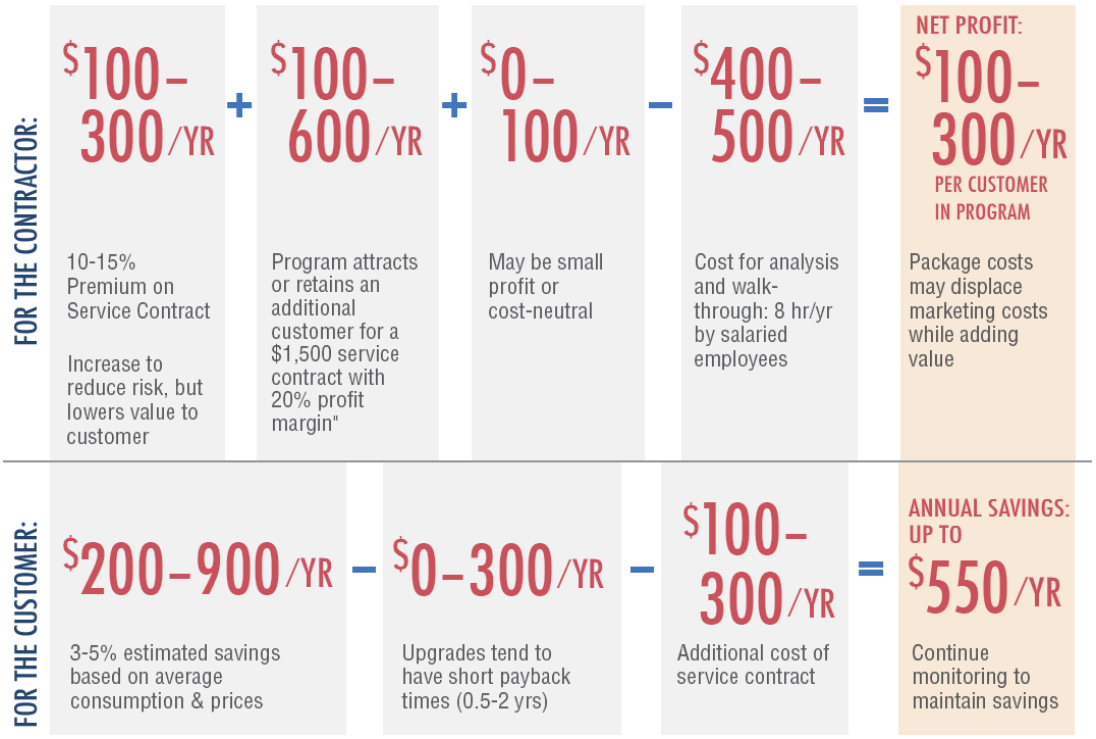

Fig 5: Example costs and benefits associated with integrating the EMP into a maintenance contract

The business model describing costs and benefits of offering the EMP as part of a maintenance contract is laid out in Figure 5 for an example case. If offering the EMP leads to the recruitment or retention of additional customers, this could lead to revenue generation for the contractor. Additional revenue may be gained if the contractor is hired to implement the efficiency improvements. Labor costs can be minimized by using salaried office staff to perform analysis at times with low service volume, minimizing required technician hours. In interviews, contractors tended to prefer contract integration over offering the EMP as a separate service. If the package were offered as a separate service, there would be lower risk to the contractor but also lower savings for the customer.

A small pilot with two contractors was conducted to assess training time and time spent on each technical element. Overall, the pilot validated these key elements of the business model. The time to execute the package was within the 4–8 hours necessary to minimize transaction costs. Estimated expected savings were within the target range of 3%–5%. A larger-scale demonstration that is underway will help to further validate the business model.

3. Discussion

Small commercial buildings are ripe with energy-efficiency opportunities. However, the logistics of energy management in this segment are complex. Specifically, data access can present a significant hurdle. The standardized file format provided by the Green Button initiative and the Green Button Connect transfer protocol has significantly lowered the effort required for tool developers to input customer energy-use data files, but not all utilities have implemented these programs. Even with

Green Button formatting in place, there is a need for an efficient process for third parties to access energy data.

Most existing tools for small-commercial energy management fall into three categories: 1. monthly data analysis; 2. benchmarking; and 3. interval data visualization. None of the tools reviewed could be used to complete 1, 2 and 3. The pilot of the EMP revealed that the time required to access data could easily surpass the time required for the analysis itself.

Contractors have been particularly interested in the use of interval data to gain insight into how and when a building uses energy. One contractor commented that screening the interval data in his office would be much more efficient than, for example, going onsite to determine whether adjusting the thermostat programming would be worthwhile for the customer. However, rollout of smart meters to small commercial customers may be limited depending on the region.

4. Conclusions and Future Work

The EMP provides an approach to target energy savings in small commercial buildings, through continuous energy management delivered by HVAC contractors. Justification for energy-efficiency expenses is often requested, and commoditized energy-management tools allow contractors to deliver building-specific information at low cost. Lowering transaction costs was identified as critical to the adoption of energy management in this sector, and recent advances in energy data access, combined with online analysis tools reduce barriers to applying energy management in smaller buildings.

To further validate the usefulness of the EMP, a demonstration is currently underway with approximately 20 partner contractors nationwide. Alternate channels being explored for delivery of the EMP include contractor training venues and owner engagement through green-business certification programs and city-level energy initiatives. Software vendors have been receptive to the opportunity to tailor products to better serve the small commercial market. Standardization in data-access protocols for both monthly and interval utility energy-use data could significantly reduce barriers to adoption of energy management.

To download the Energy Management Package and associated resources, please visit http://eis.lbl.gov/smallcomm.html.

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